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SOME RECENT ADVANCES IN THE STUDY OF POLIOMYELITIS

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It is the object of this brief review article to present to the general reader some of the more significant advances that have recently been made in the study of poliomyelitis by laboratory methods, with particular reference to the prevention of the disease.

The Pathogenesis of Poliomyelitis

It is probable that poliomyelitis virus enters the human body through the mucosa of the pharynx or intestine. Certainly, chimpanzees and cynomolgus monkeys can readily be infected by feeding them with virus. Although there is general agreement about the portal of entry of the virus in man, there is sharp divergence of opinion regarding the subsequent routes of invasion of virus through the human body before it finally reaches the central nervous system. The present theories regarding this phase of pathogenesis are based largely on the results of experiments on primates. Thus, the extensive studies of Faber have shown that virus rapidly enters peripheral nerve ganglia and then spreads centrally by nerve fibres. The work of Horstmann and of Bodian has focussed attention on the role of blood in the transportation of virus, for they have detected viraemia in the incubation period in chimpanzees and cynomolgus monkeys infected by feeding. The additional demonstration that the presence of relatively small amounts of antibody in the peripheral blood will protect animals so exposed to virus also lends support to the theory that viraemia plays an important role in pathogenesis. To explain viraemia, it is necessary to postulate that poliomyelitis virus proliferates extensively in the body in extraneural tissues such as the intestinal or pharyngeal mucosa and the viscera.

Light on the pathogenesis of the disease in naturally exposed humans, as distinct from experimentally infected primates, comes from various sources. Thus, poliomyelitis illnesses in children frequently have a two-phase or dromedary course. The first or minor phase of the illness, characterized by fevers, headache, sore throat, and listlessness, may well correspond to a period of invasion of the blood stream by viraemia. There is then a period of remission lasting for a

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few days, following which the second or major phase of illness commences and usually culminates in paralysis.

Recently, Horstmann has isolated poliomyelitis virus from the blood of three children suffering from a mild abortive type of illness, and this observation lends considerable support to the theory that viraemia plays an integral part in pathogenesis. Nevertheless, viraemia may not necessarily lead to invasion of the central nervous system, for the children studied by Horstmann recovered quickly and did not develop the second phase of the illness. It is quite likely that many infections with poliomyelitis virus, probably the majority, do not progress beyond a transient viraemia. If this view is correct, we should look for factors which serve to transform a viraemia into a severe illness complicated by paralysis. There is some experimental evidence that cortisone may perhaps act in this way. The influence of this or other hormones may explain the fact that poliomyelitis in pregnancy is often severe. Attention has recently been drawn to the fact that irritant injections, for example, alum-precipitated diphtheria toxoid with pertussis vaccine, or arsenicals for the treatment of yaws, if given intramuscularly during a poliomyelitis outbreak, may serve to localize paralysis in the inoculated site.

Another finding which tends to support the importance of viraemia in pathogenesis is the demonstration by Hammon and his colleagues that poliomyelitis can be prevented in a proportion of exposed children by means of an injection of poliomyelitis antibody in the form of gamma globulin.

Much further work is needed, but meanwhile it would appear probable that viraemia is an essential stage in the dissemination of virus through the body. Whether virus reaches the central nervous system directly from the blood, or whether it finally arrives there by passage along nerve fibres following an initial phase of viraemia is not yet clear.

The Tissue Cultivation of Poliomyelitis Virus

Enders and his colleagues Robbins and Weller of Boston have shown that all three Types of poliomyelitis virus proliferate readily in tissue cultures of human organs. This original work has been developed by many workers, including my associates in Toronto, and it is now known that the viruses proliferate in the cells of tissue cultures not only of human embryonic tissues, but also of human uterus, testis, kidney, and tonsil, as well as of monkey testis and kidney. The cells that proliferate in such cultures are either fibroblasts or epithelial cells depending on the origin of the tissue. When poliomyelitis virus is added to a culture of fibroblasts or epithelium in a roller tube, the outgrowing cells degenerate in a few days and a most characteristic "cytopathogenic effect" is produced. This fact can be made use of in the isolation of poliomyelitis viruses direct from stools, throat washings, blood, or central nervous system, in the titration of viruses, and in the measurement of specific antibody, for antibody inhibits specifically the cytopathogenic action of the virus.

Poliomyelitis virus can be produced in quantity in roller cultures of monkey testis fibroblasts or of epithelium from monkey kidney. These cultures can be prepared in large rotated test tubes or bottles. In this way, large volumes of virus-infected fluid can be obtained.

Antigenic Typing of Poliomyelitis Viruses

There are three main Types of poliomyelitis virus, known as Type 1 (Brunhilde), Type 2 (Lansing), and Type 3 (Leon). These strains are antigenically distinct, and there is good evidence that second attacks of the disease in man may be caused by a type antigenically distinct from that which caused the first illness. Typing was originally performed in monkeys, but can now more quickly be carried out in tissue cultures. The commonest Type causing paralytic poliomyelitis in the United States of America and in Canada is Type 1, but infections with Type 3 have been reported not uncommonly. Type 2 infections seem very rarely to be complicated by paralysis, but serological evidence suggests that symptomless infections with this Type are in fact very common and give rise to Type 2 antibody which circulates in the blood of most adults.

Prospects of Vaccination against Human Poliomyelitis

It has been known for many years that monkeys can be rendered resistant to poliomyelitis by the injection of live virus. The state of resistance seems to be dependent mainly, or perhaps solely, on the height of the serum antibody titre that develops following such injections. In work of this character, the source of virus has usually been the central nervous system of infected monkeys. More recently, monkeys have been immunized by virus produced in tissue cultures.

Some years ago, work had progressed to the stage where experiments on children seemed to be justified. A large number of children were injected with vaccines prepared from infected monkey central nervous system, and treated with recinoleate or formalin to inactivate the virus. Several cases of paralysis were attributed to these injections, and it is only now, some twenty years later, that the subject is being re-investigated. In the interim, we have learned that virus can be produced in tissue culture, and that the antigenicity of virus inactivated by formalinization can be enhanced by incorporation with an oily adjuvant. Dr. Jonas E. Salk of the University of Pittsburgh has pioneered this work in the United States of America, and further progress is anticipated shortly. Already small numbers of children have received experimental vaccines, with safety. It may be of interest to Toronto readers to know that a discovery made by a group of workers at the Connaught Medical Research Laboratories has materially assisted and expedited this vaccination programme. A synthetic nutrient known as "Number 199" developed by Morgan, Morton, and Parker has been shown by my associates Farrell, Franklin, and Wood to allow of extensive virus proliferation in cultures of monkey kidney. Virus so produced is free of foreign protein other than a small amount yielded by the monkey kidney.

Gamma Globulin in the Prevention of Poliomyelitis

Poliomyelitis antibody is present in gamma globulin prepared from the pooled serum or plasma of adults. Recently, gamma globulin has been prepared in the Connaught Medical Research Laboratories, and this product resembles closely that prepared in the U.S.A. for the American Red Cross and by various drug houses.

Experimentally, it has been shown that gamma globulin prevents poliomyelitis in mice and monkeys. The re-

cently published studies of Hammon of Pittsburgh and his associates have shown that gamma globulin may also act as a prophylactic in the field. These workers administered gamma globulin and a control preparation of gelatin intramuscularly to children aged 1-11 in 1951 and 1952, in three epidemic areas of poliomyelitis. The incidence of paralysis developing in those inoculated with gamma globulin was significantly less than in those inoculated with gelatin. The protection conferred by gamma globulin appeared to last for 4-5 weeks.

Supplies of gamma globulin in Canada in 1952 are strictly limited, but should be more abundant in 1953.

Conclusions

It would appear that poliomyelitis is a disease in which viraemia plays an important role. Recent work suggests that viraemia and the more serious subsequent invasion of the central nervous system can be prevented in man by the prophylactic administration of poliomyelitis antibody in the concentrated form known as gamma globulin. It is anticipated that the injection of a poliomyelitis virus vaccine, perhaps prepared in tissue cultures, will stimulate sufficient circulating antibody likewise to prevent viraemia and paralytic complications. The future outlook in the control of poliomyelitis is full of promise.

References

Readers are referred to a recent more complete review by the author: Rhodes, A. J., 1953, *British Medical Bulletin*, Special issue on "Virus Infections", also to Rhodes, A. J., and van Rooyen, C. E., 1953, "Textbook of Virology", 2nd Edition, William & Wilkins, Baltimore.

TRENDS IN THE INCIDENCE AND AGE DISTRIBUTION OF POLIOMYELITIS IN CANADA

M. H. BROWN, O.B.E., M.D., D.P.H., F.C.C.P.

The data presented were obtained from Dr. R. Kohn, Chief, Public Health Section, Health and Welfare Division, Dominion Bureau of Statistics, Ottawa.

The figures presented and the charts based on these figures refer to notified cases which are contained in the weekly reports from the provincial health departments to the Dominion Bureau of Statistics. In other words these data are based on reported cases only.

During 1953 Canada experienced the highest attack rate of poliomyelitis of any year since reporting to the D.B.S. was instituted in 1924. There were over 8700 reported cases and approximately 400 deaths. The majority of these cases and deaths occurred in the four western provinces and Ontario.

It is interesting to observe the trend in Canada over the past thirty years. Chart I shows the number of reported cases of poliomyelitis in Canada from 1924 onward. A general upward trend is noted and if it were possible to extrapolate below the year 1924 and above 1952 three general levels of incidence might be detected, the first one up to 1926, the second one up to 1945 and the third beginning with the year 1946. The peak years of epidemics rise sharply above what might be termed the endemic level of each period. These occurred at intervals of four to six years before 1946 and in more rapid succession thereafter. In point of fact, save for 1948 and 1950 there has been no drop in the peak since 1946. This change in periodicity is an interesting observation and may offer a clue as to the trend in the immediate future. The increasing trend prevails in all provinces but the peak years vary for different areas. The high figure for Canada in 1931 was due largely to the epidemic in Quebec, in 1937 Ontario accounted for most of the cases, in 1941 Manitoba and New Brunswick were the chief centres, in 1947 several provinces, chiefly Ontario and Manitoba, contributed to the total, and in 1952 the prairie region bore the brunt as it did in 1953.

A seasonal trend has been associated with the incidence of poliomyelitis, namely the summer months, despite the recently reported outbreak in the far north which occurred in the midst of winter. The week of the highest number of cases for Canada has fallen invariably within the period from August to October, although in British Columbia the peak week occurred once in July and once as early as June. In more recent years the peaks have tended to subside more slowly, and the year 1953 was a good example of this tendency.

The term "infantile paralysis" has practically disappeared from our nomenclature, being replaced by poliomyelitis, and this is probably a consequence of the trend towards a higher incidence among older age groups.

In 1942 only about six per cent of the cases occurred in the 20 and over age

group, whereas in 1952 this had risen to about 25 per cent. The percentage of deaths for the 20 and over age group is likewise on the upgrade.

There are two aspects of interest in the recent trend of poliomyelitits, namely an apparent general increase in the incidence over the past thirty years and an upward trend in the age groups attacked and in those who succumb to the disease. This assumption is based solely on the reported cases.

POLIOMYELITIS

Chart - 1

NUMBER OF CASES

CANADA

RATES PER 100,000 Chart - 2 RATES (CANADA) RATES PER 100,000

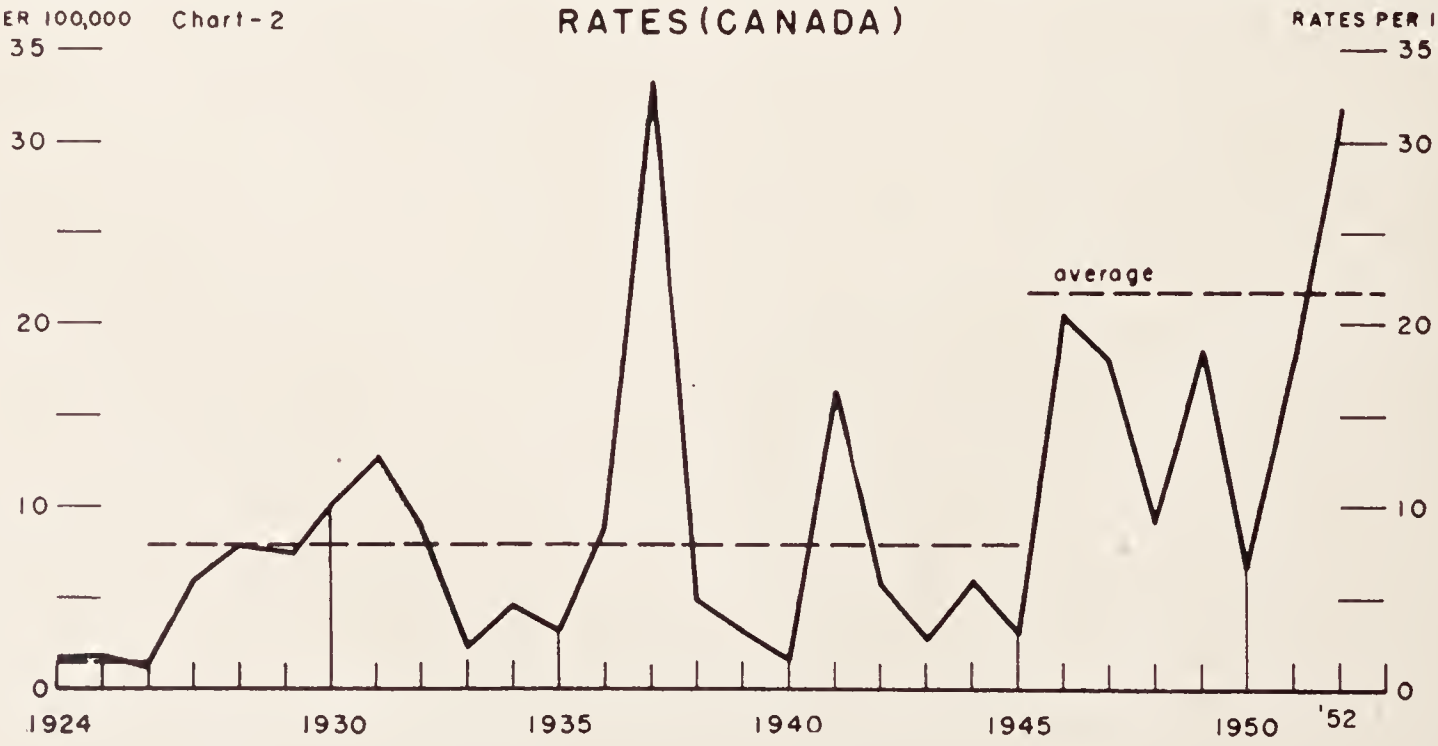
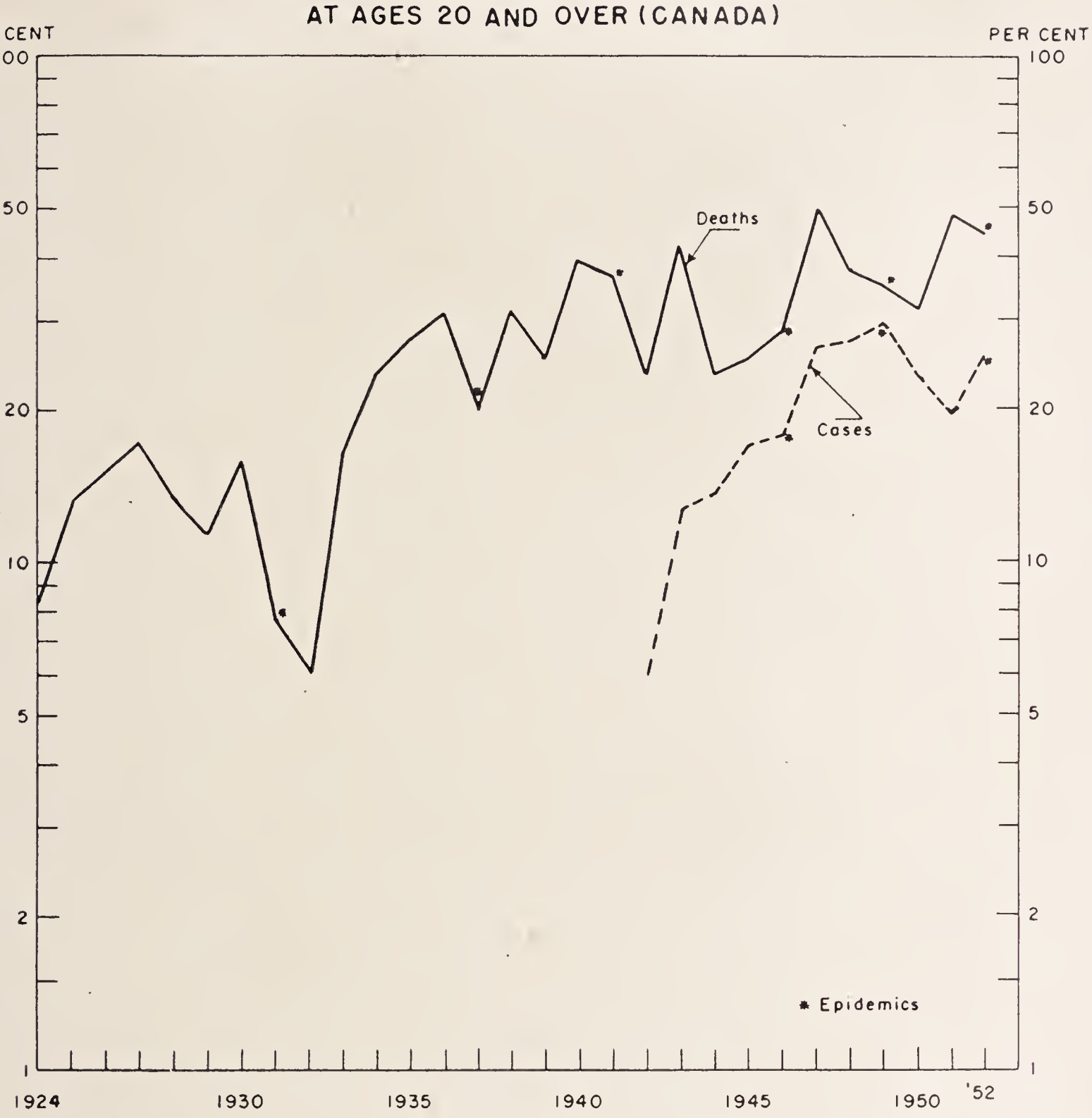


Chart-3

PERCENTAGE OF DEATHS AND CASES
AT AGES 20 AND OVER (CANADA)



SOME CLINICAL ASPECTS OF POLIOMYELITIS IN CHILDREN

ANN PEACH, M.B., D.C.H.*

The classical symptoms, signs and diagnosis of acute anterior poliomyelitis are given in every standard textbook of paediatrics. It is easy to diagnose poliomyelitis if the illness follows the lines described in these textbooks, but very often the illness may not be classical and knowledge of the aberrations and sequelae of the disease may allow the physician to make a correct diagnosis and not a fool of himself.

The purpose of this article is to mention a few facts not often dealt with fully in textbooks and to give a few suggestions in examination, especially of the younger children.

Very often in young infants there may be only minimal prodromal symptoms, for a baby cannot complain of headache, and all that is noticed is that the child may be irritable and cry when his head or neck are touched. The mother may then notice that he does not kick his legs or use his hands as much as he did before, and by the time medical aid is sought, the baby has a flaccid paralysis of one or more limbs, and the diagnosis is easily confirmed by C.S.F. examination.

However, this paralysis may not be complete and the mother may not be absolutely certain if the baby is moving less than he did before. It is useful to be able to decide if actual paresis exists. This is especially important if C.S.F. findings in an irritable baby are suggestive of poliomyelitis. Also it must be remembered that some babies may not move a limb not because they can't but because they don't want to, usually because of pain in the limb. It is now that trickery in examination has to be resorted to, and this is useful both in diagnosis, and also in the estimation of the extent of paralysis in the established case.

Arm movement can be demonstrated by grasping the baby's hands while he lies on his back and gently pulling him to a sitting position. The baby will flex his arms at the elbow, will adduct his arms and will also grasp with his fingers. A slightly older infant, between nine and eighteen months will often resent this manoeuver and try to pull his hands from your grasp. Therefore a good estimation of power and symmetry of power can be obtained. Again an infant over six months, once his interest has been aroused, will 'reach for' a toy held above his head and so shoulder movement can be estimated. If a baby is protesting and kicking vigorously, you can estimate leg power by holding his feet in your hands and allowing him to kick against slight restraint. However, if he is lying quietly on his back, you can get a good idea of most movements by gently restraining the leg and pricking the sole of his foot with a pin—diaper pins are always available in this age group. The immediate reaction is to withdraw his leg and so ankle flexion, knee and hip flexion, and also adduction can be tested for. If paresis is present the baby will cry and not withdraw, if 'pseudo-paresis' is pres-

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ent as in injury, the baby will cry and withdraw.

In infants the differentiation from meningitis is rarely difficult, as infants never seem to be so acutely ill with poliomyelitis, and remain alert and willing to take their feedings. In slightly older children the differentiation from purulent meningitis is more difficult, as in these children the onset of poliomyelitis is marked by more severe symptoms, and they have headache, sore necks and fever. However, in poliomyelitis, the fever is rarely as high as in meningitis and the child remains alert and co-operative despite quite definite meningeal signs. In addition the child with polio may have a marked tremor of the hands and lips, which is not seen in meningitis, and he may complain of pain or a heavy feeling in his limbs, although there is no actual evidence of paralysis at the time of examination.

One major exception to the rule of the polio child being alert, is the child with bulbar poliomyelitis, who may be semi-comatose when first seen. However, before this stage is reached, paralysis has occurred in the muscles supplied by the lower cranial nerves, and to the story of headache, stiff neck and fever is added the story of nasal speech and regurgitation—"he began to talk differently, Doctor, and to slur words with l's and t's. Also when he drinks, fluid comes down his nose, and he has difficulty in swallowing saliva". So often the valuable signs of nasal speech and swallowing difficulty are ignored by practitioners, and it is explained away by a "sore throat due to tonsilitis". Therefore in these children it is important to examine the throat carefully, and not just glance at the fauces. Failure of movement or unequal movement of the palate will be seen if the child is asked to say "ah" when the mouth is open and the tongue is half protruded. Actual movement of the pharyngeal muscles must be looked for and this is demonstrated by touching the posterior pharyngeal wall with a tongue depressor and if paralysis is present, only one side of the pharyngeal wall will be seen to move or there may be no movement at all. It is most important to examine for this evidence for it may be the only paralysis that is present and because it is not external and obvious it may be missed.

Much thought and action has been devoted to the rehabilitation of paralysed children, but little consideration has been given to the after life of children who have had bulbar polio, not accompanied by paralysis other than of the muscles supplied by the cranial nerves, and to the non-paralytic patient. Too often the parents have been told "you are lucky that it wasn't a lot worse" and they are not given advice about the future handling of the child. It must always be remembered that admission to hospital is an emotional upset for any child, and the emotional instability of a child seems to be more marked after poliomyelitis than after other diseases. These children are easily frightened, have unexplained temper tantrums, cry with little provocation and cannot mix and play with other children as they did before their illness. This seems to be a temporary state which lasts anything from six to twelve months. It is in this time of readjustment that the parents need so much advice about management. They should be warned what to expect when the child leaves hospital, and they should be counselled to have patience with the outbursts of crying, to reassure the child when he is frightened and make

him face up and not run away from that which is frightening him. They should be firm but understanding with the child in a temper tantrum and also be prepared to straighten out arguments and ill feelings which may have occurred with the child's playmates at school. Primarily they should be made to understand that this change in the child's character is likely to be temporary and that in the fullness of time he will again be the child he was before his illness.

You and I have many things to do in life—and the first condition of doing them is to take care of health, and not get ill again, which is worse than a folly, it is a sin; and the second condition is to waste no time except what is required for health. —Jewett to Prof. Lewis Campbell 1879.

CASE REPORT

ANN PEACH, M.B., D.C.H.

S.C., female, aged 11 years.
Admitted 29/7/53.
Discharged 25/11/53.

History of Present Illness

5 days ago—fell and hurt back of neck.

4 days ago—vomited on two occasions, not since. Developed fever of 101°F, which has continued intermittently since.

3 days ago, and since—complained of pain in the back of her neck. No headache, no sore throat.

Day of admission—became rather drowsy, had difficulty in swallowing and speech was slurred. Had a "gurgling" noise in her throat when breathing and especially when asleep. Bowels not open for past 3 days.

Past Illness

Measles and chickenpox.
Colds.
Tonsils and adenoids removed 1949.
Otherwise healthy.

Family History

Only child.
Father and mother alive and well.
No illness in household or in neighborhood.

Physical Examination

A thin, normally developed, eleven year old, white, female. Slightly dehydrated. Drowsy but responds to questions and carries out movements when asked to do so. Slight tremor of hands and lips when these are in motion.

HEAD AND NECK

No abnormalities in contour.
Slight right facial weakness apparent.
Pupils equal and react to light.
Fundi normal.
Ocular movements full and equal.
No nystagmus.
Ears—healthy, Nose—healthy.
Teeth and tongue normal.
No tonsil remnants. Fauces slightly red.
Palate arches on left and pulls uvula to left. Rt. palatal weakness.
No pharyngeal movement demonstrable.
Some frothy mucus in pharynx.

C.V.S.

Tachycardia. No murmurs. B.P. 110/60.

RESP.

No cyanosis, rate regular.
Chest movement good and equal.
Air entry good. No advetitia.

ABDOMEN

No masses or tenderness.
Bladder not distended.

C.N.S.

Slight neck and back stiffness.
Kernig negative.

Reflexes		*Rt.*	*Left*
Arm.	Biceps	+	+
	Triceps	—	—
	Supinator	+	—
	Pectoral	—	—
Leg.	Knee	+	+
	Ankle	+	+
	Plantar	+	+
Abdomen		+ | +	
		+ | +	

Power

Gross power in leg muscles equal and good.
No deep muscle tenderness.
Weakness of neck flexors, both deltoids and of trapezius on left. Difficult to ascertain correctly because child is drowsy.

SKIN—clear and healthy.
LYMPHATICS—No adenopathy.
GENITALIA—Normal female.

INVESTIGATIONS

C.S.F.—cells 230., 30% polys—70% lymphs. Protein increased.

TREATMENT

Postural drainage position—foot of bed raised to an angle of more than 20°.
Frequent mouth suction.
Constant supervision.
Intravenous fluids.

PROGRESS

29/7/53—Started on I.V. fluids. Semicomatose and irritable but allows herself to be suctioned. Requires suctioning every 15 minutes.

30/7/53—Still semi-conscious. Respirations shallow but regular. Intercostal and diaphragmatic movement fairly good. Chest clear. Still pyrexial.

31/7/53—Respirations rather irregular, pulse rising, colour fair. Intercostal movement—fairly good. Put on nasal oxygen with some improvement. Temperature down. Still semi-conscious.

1/8/53—Responding and answering questions. Able to swallow a little under supervision. Still requiring frequent suctioning. I.V. discontinued. Generalized apparant paralysis of whole of left arm apart from a little finger flexion and extension. Generalized weakness right shoulder and upper arm. Good movement in right hand. Extent of paralysis difficult to determine accurately because of spasm in both biceps and pain on straightening elbows and moving shoulders.

3/8/53—Now fully conscious and swallowing pureé food, but still requires suctioning.

14/8/53—Swallowing well. No suctioning required. Some movement in left hand and good in right.

18/8/53—
Transferred to Thistletown for physio and hydro therapy.

Condition on transfer

Rt. facial weakness improved. Little change in palatal weakness although speech has improved.
No movement in pharynx.

Power in arms—gross findings.
Left—wrist and hand—fair,
—forearm, upper arm and shoulder groups—trace poor.
Rt. —hand and wrist—normal,
forearm and upper arm—fair,
shoulder—trace.
Back poor.
Legs normal.

On discharge home

Left shoulder trace.
Remainder of arm fair good.
Rt. shoulder fair.
Remainder of rt. arm—normal.
Wasting of lt. shoulder and upper arm.
Back improved.

Discharged home with spinal brace and bilateral abduction splints to be worn when ambulant; correction splints to be worn in bed.

COMMENT

This is a case of bulbo-spinal poliomyelitis which shows progression from the encephalitic phase of the disease to a very good recovery.

The development of a promising vaccine against infantile paralysis, which succeeded last year's discovery that the blood derivative gamma globulin is capable of providing temporary protection against polio, was rated by experts as the top U.S. medical achievement of 1953. Mass field trials of the new vaccine are planned for 1954. Preliminary tests indicate that it may protect inoculated children, for three years or longer, against the three known types of polio virus.

CONVALESCENT CARE OF POLIOMYELITIS

W. T. MUSTARD, M.D.

The care of a patient partially paralyzed as a result of poliomyelitis is a challenge to the medical profession to defend its reputation. Perhaps no other disease is prone to such false lay impressions, charlatanism, and reported cures. Recently in one of our daily papers was a report of a girl who though completely paralyzed from an attack of polio made a complete recovery over two years with the help of doctors, nurses, physiotherapists and her own determination to become normal again. This patient (one of mine) had polyneuritis. A swimmer who placed second in an Exhibition marathon had overcome his handicap of poliomyelitis. This man had a cup arthroplasty performed by the late M. N. Smith-Petersen for slipped femoral epiphysis. Such confusion exists in the public mind that it behooves the medical profession to cling to science and to treat poliomyelitis on the basis of the pathology of the disease and not the psychology of the masses.

The patient with relatively minor involvement soon loses the pain on muscle stretching, and any weakness which is present recovers more or less completely. These patients are usually able to get up and if they avoid fatigue during the next few months, make a complete recovery. Patients who show muscle weakness after accurate muscle testing a month from the onset require further care. Those who have severe involvement require prolonged observation in order to obtain maximum function with minimum deformity.

Treatment during the early convalescent phase has, as its main object, the prevention of deformity and assisted active movement of muscles in which there is power. It is useless to treat muscles which have no active power, but muscles which show some power should be given an opportunity to increase in power, even in the early convalescent stage. This may be accomplished by assisted active motion on the part of a physiotherapist or by hydrotherapy.

While it is true that recovery during this stage depends primarily upon the original involvement of anterior horn cells, any active motion of the muscle itself may stimulate partially damaged cells to function. A recovering muscle fatigues quickly and active motion should not be carried to the point of fatigue. Experience has shown that fatigue in a recovering muscle not only delays recovery but may even jeopardize any ultimate recovery. Splinting in functional positions has been shown to prevent deformity and to aid muscle recovery. This is best exemplified by the opponens in the hand. The use of electric stimulation, massage, heat and various other modalities in this phase of recovery have not been proven to be of any value.

Minor degrees of involvement permit earlier ambulation than has been previously practiced. Fatigue should be avoided but prolonged bed rest is not of much value, and indeed may be harmful.

In the moderately severe cases, hospi-

talization is desirable but not entirely necessary if proper supervision is available. In the more severely involved, hospitalization and bed rest is required. It is in this period that maximum muscle recovery is usually obtained in those muscles which show some return of power. It is also in this stage of the disease that a prognosis may be safely made. Muscles which have shown no recovery four to six months from the onset are unlikely to develop any useful power.

Muscles which have poor or better ratings will usually show improvement with adequate rest and proper physiotherapy, which should be in the nature of assisted active motion.

Muscles which have fair or better ratings will usually improve to a functional level. It is at this stage of recovery that muscle evaluations done monthly are of considerable help in decisions for future treatment.

Crutch walking, bracing and increased exercise should be considered in all but the most seriously involved at the end of six months. The general trend in the convalescent care of poliomyelitis patient is toward earlier rehabilitation.

In childhood and particularly in infancy, deformities develop even despite adequate splinting, nursing care and physiotherapy. The deformities which develop early are static deformities due to fascial contracture—the most common example of this is shortening of the ilio-tibial band which develops quite quickly in infancy and is not helped by the use of diapers.

The leg affected by the contracture of the ilio-tibial band, is of course, the paralyzed leg, and when the legs are brought together there is an apparent increase in the length of this leg due to a fixed pelvic obliquity.

This deformity must be recognized and corrected early to prevent secondary deformities from developing. We have found it necessary in infancy to divide the ilio-tibial band and intermuscular septum as early as four months after the onset of poliomyelitis.

Another static deformity which is common in childhood is the development of equinus even in the absence of any real power in the calf. It is wise to treat this deformity conservatively so that later the tight calf acts as a tenodesis.

Other static deformities involve the arm and particularly the hand. Hyperextension at the metacarpal phalangeal joints, flexion of the fingers, adduction contracture of the first metacarpal to the second and palmar flexion of the hand at the wrist may develop early. Prevention is the only really successful means of therapy and adequate splinting very soon after the onset of the disease is necessary.

In the severely involved patient, and particularly in the respirator case, preventing deformities early in the disease is the only effective treatment, since the patient is unable to assist in any active form of treatment.

Kinetic deformities develop in childhood more quickly than they do in adults. A common example of this is varus of the foot in the presence of a normal posterior tibial acting unopposed. It may therefore be wise, even in early convalesence, to divide or transfer a deforming muscle.

Other kinetic deformities do not usually become apparent until an attempt is made to use the limb. Such deformities not only increase, but produce deformities of bone. These secondary deformities of bone are difficult to correct by an indirect attack on the musculature. It is

apparent then that when deformities are obviously becoming progressive, treatment should be early rather than late. Hypertrophy of opposing muscles which are weaker than the deforming muscle or muscles is an obvious method to overcome progressive deformity. In most cases, however, the opposing musculature is completely paralyzed, and it therefore becomes necessary to transfer deforming muscles before the stage of residual paralysis.

Kyphosis and lordosis are deformities seen in poliomyelitis which are not often progressive but are simply due to symmetrical paralysis of spinal musculature. Scoliosis, on the other hand, is a progressive deformity which may be insidious in its onset and severe in its result. Very little can be done in its prevention except in those few cases due to pelvic obliquity or actual paraspinal contracture. Recognition of the presence of a curve is however important and standing X-rays with the pelvis level should be taken frequently. Corrective jackets may be of some assistance in ambulation but do not correct a curvature.

Six months to a year from onset very little further recovery in the central nervous system can be expected and any increase in power in musculature is due to hypertrophy. Muscles which show power six months to a year after the onset of poliomyelitis will generally show an increase in power for a period of a year or two. There are certain muscles, however, which are notorious for not demonstrating this increase in power but actually occasionally becoming weakened with exercise. Such muscles are the anterior tibial; gluteus medius; and the deltoid. Muscles which have no power or only a trace of power six to eight months from the onset very seldom recover any useful function.

There are three accepted forms of treatment in the residual stage. The first of these is bracing; second is tendon transfer; and the third stabilization. Bracing is generally confined to the paralyzed lower extremity and it is only when complete paralysis exists that permanent bracing should be employed. Bracing the spine may be necessary for support when other procedures are contra-indicated.

REHABILITATION FOLLOWING POLIOMYELITIS

A. T. JOUSSE, M.D.

The rehabilitation needs of an adult following poliomyelitis are determined by an evaluation of the paralysis and resulting impairment of function in relation to the daily requirements at work and play. Where the loss of function is slight or is confined to some portion of the body not essential to his vocation, no special measures are indicated apart from treatment designed to assure the maximum recovery. As the majority of patients acquiring poliomyelitis with paralysis fall into this class, it follows that their management is not essentially different from that required for a person with a fractured femur, a painful back or heart disease. Maximum function is restored, certain adjustments may be necessary at work and in daily living, and the patient is encouraged to carry on.

The significance of even minor disability is quite different for infants and children, and is much more serious. Play must be considered an important part of a child's life, and anything which prevents him from participating enthusiastically and strenuously may be very damaging to the child's happiness, as it tends to set him apart. Even so, the limitations imposed may not be different from those resulting from heart disease, arthritis and other orthopaedic disabilities.

When the disability is such as to completely sever the patient from his former way of life, rehabilitation becomes a major problem, for in addition to restoring power and function, ways and means must be devised to enable the casualty to master physical independence including locomotion and economic independence.

The problem thus has three aspects:

The first concerns itself with restoration of power and function in weakened muscles and the prevention of deformity. Concurrently, physical well-being must be regained.

The second may require the use of prosthetic devices to brace the weakened limbs, the use of crutches, the introduction of substitution activities, and the teaching of trick movements.

The third requires an evaluation of the patient's total remaining assets of intellect and character and the guidance of the individual into new vocational channels. It necessitates helping him to relinquish the goals and ambitions he held before becoming disabled, and to establish new ones which are realistic and attainable in the light of his altered capabilities.

Restoration of power and function must be dealt with first. Apart from neurological recovery which is independent of treatment, power is restored to partially paralyzed muscles by re-education and active exercises which if properly applied for a sufficiently long period of time will lead to the best functional result.

The proper time for the introduction of re-education and active exercises has not been determined with accuracy, and as a result there is much variance of medical opinion on this point. There are advocates of complete rest for months

and advocates of early activity as soon as the acute phase subsides, (1) (2). In practice there is little difficulty in determining when active exercise should be introduced if one bears in mind that the effect of the disease and the severity of the paralysis varies from one patient to another, and that the decision must be made in accordance with the patient's condition.

All are agreed that active exercise should not be introduced until the acute phase has passed and the temperature is normal, which may be two weeks after the onset. An additional two weeks of bed rest is indicated in view of the danger that late paralysis may sometimes develop. This takes one to the end of the first month. If the paralysis has been but slight, no muscles being completely paralyzed, active exercises can be introduced safely at the end of the first month, but bed rest is still indicated, although excursions to the bathroom are acceptable. The patient should not be up walking if there is involvement of legs or trunk, but if the paresis is present in the muscles of the arms alone, he can be up and about safely, using proper splinting of the upper extremities. Return to competitive activities should not be permitted.

On the other hand, where the patient has had a very widespread paralysis with severe systemic involvement, he will not have regained sufficient stamina to enable him to exercise strenuously for three to six months, or even longer, after the acute stage. If carefully supervised, such a person is not in danger of overworking his weakened muscles, for signs of fatigue are obvious and general weakness serves as a check on strenuous and prolonged activity.

Where muscle paralysis is complete and no evidence of recovery is noted at the end of two months, there is little reason to believe that useful recovery will ever take place. Hence, resting the completely paralyzed limbs is without point and the normal muscles may be exercised as strenuously as the general state of well-being permits.

From the onset of the disease daily passive movement is required at all joints of the involved limbs. Contractures which may cause deformity and thus lead to permanent impairment of function quite part from the paralysis are thus prevented.

The early treatment thus consists of passive movement to prevent deformities; if the paralysis is slight the patient will soon initiate the active movements necessary for shifting his position in bed. If paralysis and systemic involvement are severe during the second or third month, active assisted exercises and re-education are introduced. The tempo is increased as the patient's well-being permits, and exercises against gravity are introduced as soon as he can tolerate such activity. Frequent assessment of muscle power is indicated in order that progress may be evaluated. Any apparent loss of power will require a modification of the intensity of exercise. When the well-being permits, general exercises to the normal as well as to the paralyzed muscles should be introduced, as endurance is thus improved.

The programme of physical restoration is only meaningful if it is directed toward a specific goal. Exercise simply to make a patient stronger does not hold his attention for long. It is necessary to relate it specifically to such an object as learning to walk again, or learning to get about in a wheel-chair or even, if the disability is severe, of mastering the simple details of self-care.

This introduces the second aspect of management, which is the restoration of physical independence. The practical activities requisite to self-care are urged on the patient as soon as it is evident that he is ready for them. There can be no hard and fast time limits. One's judgment is based on the rate of recovery of power and function and the state of well-being. This is determined by talking to the patient, by noting appetite, weight gain or loss, complexion, pulse rate. No two cases will progress at exactly the same speed; hence, rigid periods of convalescence are meaningless, as they are too long for the patient who is recovering rapidly and too short for the one who is recovering slowly. Frequent evaluation of progress is the key to proper management.

The detailed programme of self-care is highly individualized. Patients retaining full use of their upper extremities may become completely independent in a few days, whereas when the arms are involved, even with the use of braces and special devices, months may elapse before self-feeding becomes possible. Physical and occupational therapists are well versed in dealing with these details. The physician should decide when the patient is ready for each advance.

The third aspect of the problem is dealt with through frequent contacts with the patient during the acute and post-acute phase of illness when the physician should become thoroughly acquainted with the man as an individual. One can estimate intelligence, evaluate moral fibre, willingness to co-operate, diligence, cheerfulness or the reverse, and thus form an accurate estimate of the type of man requiring assistance. Education, interests and ambitions can be learned through conversation. One must also become acquainted with the family, to whose midst the patient will probably return. With the assistance of the social worker and the vocational counsellor, a planned programme of vocational training can be worked out which is acceptable to the patient.

The programme is only successful if it receives the total support of the casualty. The essence of rehabilitation is thus to assist the man to accept his disability, relinquish his previous goals and establish new ones, and to pursue the new goals with all the determination at his command. Such an adjustment can be effected by a few individuals without assistance. The majority require advice and guidance from the doctor in charge of the case. The importance of this aspect of management is such that it should not be left to other members of the treatment team. However, all members of the team should be made conversant with the programme and must lend their support. A few individuals cannot effect the adjustment, and rehabilitation becomes impossible.

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EDITORIAL

Much has been said recently about the change from the "good old days", when salesmen used all means available to SELL a product or service. They were especially careful that their information was most attractive and interesting. The complaints state that most so-called "salesmen" are really only clerks who are too apathetic and uninterested in their work to attempt anything requiring an expenditure of energy (unless they are on a holiday).

In the schools, *occasionally* the same complaint arises. There are few Socrates to inspire the students to rise to dizzying heights on the wings of thought, but many other purveyors of knowledge are present. One such type, is the "spoon-feeder", who attempts to make the student's life a sinecure. While this does make a tangible amount of knowledge available in an organized manner, it does so without causing the student to actually think. Rather than yielding a good understanding of basic principles involved, it tends to favor "rote" learning. Closely akin to the above, is the "race-track tout" type who tells students that they must learn certain information because it would constitute "a good examination question". Quite often, he will quote odds on the probability of a certain question occurring on an examination paper. Very rarely, he will provide information which has a comforting or life-saving potentiality. Of course everyone knows that knowledge for its own sake is never discussed by discreet students.

Another not uncommon type, is the "Simon Legree", who begins his lecture

with the warning, "you won't find this in any of the textbooks, so you had better copy this down". Nine pages later, after the furious copying has ceased, the students lift their heads to discover that their mentor has disappeared and they are left with a fistful of gibberish which will take two hours of concentration and solitude to decipher. During the period of copying they have learned almost nothing. A fourth type is the "prima donna", whose erudition is (by his own admission) so overwhelming, that his harangues must never be interrupted. The poor student has no recourse, for he must be present (in accordance with the regulations) and so be exposed to the continual droning, without any opportunity to ask questions. While these forms of the species are only occasionally encountered, it is felt that the student must be made to make an early diagnosis and institute the necessary counter-active measures.

We are fortunate, for many of the outstanding educators in this school are aware of the need for increasing the efficiency of the teaching programs. We have seen many changes in our courses take place; our opinions have been solicited and also our co-operation. The phrase "all's fair in love and war" should be amended to include teaching, in order that anything which tends to stimulate thought and increase learning efficiency, in a reasonable manner, can be considered desirable and good.

Educators have the opportunity of realizing and acting on the challenges presented by the needs of society. They can mold the future leaders of the community and aid them in achieving their full potentialities.

F.P.C.

THE SUPPOSED CONFLICT BETWEEN THE HUMANITIES AND THE SCIENCES

STEWARD BASTERFIELD, B.Sc.(Lond.), Ph.D.(Chicago)*

It is desirable at the outset to outline as clearly as possible what is meant by the terms humanities and sciences. Science is commonly understood to refer to organized knowledge of the external world, knowledge based on observation and experiment, and involving generalizations and interpretation of these by hypotheses and theories, the latter in turn being verified by appeal to additional facts or data. This general body of science is subdivided into special departments such as physics, chemistry, astronomy, biology, geology, all concerned with some aspect of the world of nature including to some extent man himself as part of nature. In the last century or so man himself has been studied scientifically and sciences such as archaeology, anthropology and ethnology, have developed rapidly, while his more recent civilized activities have given rise to the social sciences—economics, sociology, psychology, and to some extent, history. These, of course, are also departments of knowledge which are allied with studies that have long been referred to as the humanities, and which have usually been sharply differentiated from the sciences, on the grounds that they dealt with characteristically human activities but not by scientific methods. The study of language and literature, of philosophy, art, music and religion, in which the main concern is with aesthetic and moral values and with the first principles of all knowledge, has long been held to be entirely distinct from scientific study and offering a completely different approach to the world of man's experience. Mathematics, although a powerful organon and instrument of research in the field of natural science is itself strictly not a natural science since it deals not with any particular field of phenomena, but with general processes of thought and reasoning and belongs rather to the philosophic group of subjects. It is essentially symbolic logic.

It may be helpful to look at the historic background of the division of knowledge represented by the humanities and sciences. The movement known historically as "Humanism" arose in the 14th and 15th centuries as a revolt against scholastic philosophy and the theological dogmatism of the later Middle Ages. Science which had risen to promising heights during the Hellenic and Alexandrian periods of Greek culture had declined under the sway of Rome and virtually disappeared in the social chaos following the collapse of the Western Empire. Theology had become the dominant interest for some centuries while the Church reorganized the life of Europe, and in the 13th century the official philosophy of the Church had been rebuilt around the recovered teaching of Aristotle; at any rate his logic and metaphysics and to some extent his science had been adapted to the needs of Church doctrine. In the meantime, Greek science and philosophy had been discovered and

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assimilated by the Muslim peoples during their incursions into Persia, Syria, Egypt and Sicily and had filtered back into Europe by way of Spain, Sicily and southern Italy in translation from the Arabic into Mediaeval Latin. The new learning which began to stir Christian scholars and leaven their narrow ecclesiastical outlook, led, in the 13th century, to a revival of science and a new interest in first-hand observation of nature even among the academic theologians. A new spirit of inquiry began to show itself and a growing restlessness and hunger of spirit became evident in the Western world. A storm of revolt against the tyranny of ecclesiastical authority was gathering on the horizon, and besides the new interest in science, one of the atmospheric conditions favouring its growth was the humanistic movement.

The desire for better translations of Greek scientists and philosophers had led scholars back to original Greek manuscripts, many of which were discovered in Sicily and Constantinople, old centres of Greek culture. The eager searchers discovered not only scientific and philosophic works but also the works of Greek and Latin poets and dramatists. It was the content of these revealed by the enthusiastic labours of scholars that gave the thought of Europe a new inspiration. The herald of this literary adventure was the Italian poet Petrarch, who caught the spirit of the classical writers and who, as one writer has put it, "sang a new song to the imprisoned souls of his fellow men". His humanistic ideal was a noble one in which self-culture and self-realization were the highest aims of the individual. Mr. J. Addington Symonds,[1] the 19th century English poet and critic, wrote of Petrarch: "What he achieved for the modern world was not merely to bequeath to his Italian imitators masterpieces of lyrical art unrivalled for perfection of workmanship, but also and far more, to open out for Europe a new sphere of mental activity. . . . By bringing the men of his own generation into sympathetic contact with antiquity, he gave a decisive impulse to that European movement which restored freedom, self-consciousness, and the faculty of progress to the human intellect." Humanism found in the study of classical literature new interest in human nature and human activities and felt the urge to set life free from the confines of theological dogmas with their emphasis on the other worldly aspects of man's destiny.

With the opening of the 15th century general discontent with the entire Mediaeval mode of thought had become evident. Possibly as Dr. Charles Singer suggests, the coming together of the two streams of Greek thought after the separate discoveries of Greek science and philosophy and of Greek and Latin literature provided a rich medium for the growth of a new cultural spirit and so the slumbering powers of the European mind woke to new life. As Mr. F. S. Marwin[2] has expressed it: "The Western mind had begun to realize that there was a world of knowledge and activity, a world in time and space, outside the area which the Church had guarded and cultivated for a thousand years." In the long run the Church could not prevent the expansion of knowledge nor keep knowledge within the bounds of any theological system however skillfully and elaborately constructed. Men inevitably returned to the direct study of nature and sought first hand knowledge of its secrets, and neither Plato nor Aristotle enshrined in cunning and venerable systems of thought could finally prevent them

storming the palisade that enclosed them and entering into possession of the larger kingdom for themselves.

About the middle of the century the capture of Constantinople by the Turks caused a migration westward of Greek scholars carrying precious manuscripts. Many found a home in Italy where the life of the wealthy city states provided just the right environment for the nurture of the new intellectual growth. Italy became the home of the Renaissance, the rebirth of learning. Its printing presses were soon turning out editions of Greek and Latin authors, and students began to throng its borders and crowd its universities. Moreover, the adventurous spirit was evident in new geographical expeditions, many of which sailed from Italian ports under Italian navigators. The great Columbus himself was born near Genoa and learned seamanship in Italian vessels. Nor is it surprising that the most remarkable intellectual figure of the century, Leonardo da Vinci, scientist, artist and engineer, should have appeared in Italy. Two of the greatest men of their age, one a scientist, the other a humanist, also were drawn to Italy from more northerly lands to catch the inspiration of the new learning. Copernicus of Cracow spent ten years in Italian universities, while Erasmus of Rotterdam studied theology and wrote important works while resident in Italy.

It may be noted that the literary or humanist revival reached its zenith before the natural sciences with their experimental and observational techniques had established themselves. The humanities with their emphasis on the study of languages, literature and history, became the dominant influence in educational curricula. Also they were more consonant with the scholastic tradition. Mathematics and astronomy which had formed part of the program of the mediaeval schools still held their place, but the experimental sciences, physics, chemistry and biology, were not officially recognized as suitable subjects for the education of the middle and upper classes. In the medical schools, of course, anatomy and physiology were important studies because of their fundamental place in the theory and practice of medicine, and doubtless other than medical students attended lectures in these subjects. However, there was no essential conflict between the humanities and sciences, since the men who took up scientific studies were themselves in general educated according to the humanistic or classical scheme and were steeped in theological doctrines. They saw no obstacles to combining humanistic and scientific studies, or to synthesizing scientific and theological thought. Regarding the relations between science and theology it need only be said that conflict arose when the scientific revolution indicated the need for a revision of the Aristotelian and Ptolemaic cosmologies, which the Church had accepted and incorporated into its sacred philosophy. To the Church it seemed that any attempt to discredit Aristotle or Ptolemy was in effect an attack on Church doctrine and threatened the authority of the whole. Hence the prolonged but unsuccessful effort to repress the new scientific findings about the structure of the universe.

But our concern is not with the historic controversies between science and theology which have erupted from time to time since the scientific revolution of the 16th and 17th centuries. It is rather the development of a coolness or anti-

pathy between the sciences and the humanities, especially in the theory and practice of education. The great development of the sciences in the 16th and 17th centuries inevitably led to a belief that scientific studies should be included in higher education. Many educationists began to realize that the discipline of scientific methods was a necessary complement to the discipline of mathematics and of linguistic study and that an understanding of Nature was an important element in an all-round culture, quite as important as the knowledge of human nature derived from a study of the classical languages and ancient history and philosophy.

The two great philosophers of the scientific movement, Francis Bacon and Réné Descartes, both educated according to scholastic and humanistic principles, led a revolt against what to them appeared to be, barren methods of acquiring and imparting knowledge. They denounced a lot of the so-called knowledge of the learned world of their time as illusory and consequently worthless, being based, they asserted, on false assumptions leading to wholly unverified conclusions. Bacon insisted that the only true way of knowledge was by inductive reasoning from selected facts of observation or experiment; that Aristotelian logic was quite useless as an instrument of discovery. He held up a glowing vision of what man might achieve by the inductive scientific method in the understanding and control of Nature and the consequent enrichment of human life.

Descartes, as a mathematician, stressed deductive reasoning, not from principles or generalizations derived from observation of phenomena, but from first principles native to the mind and independent of experience, but clearly discerned by an intuitive process of thought. Experiment or observation was, to him, largely a matter of checking deductions. He insisted that men can only arrive at real knowledge by discarding accepted views of things and going back to the simplest possible ideas clearly presented to their minds, and proceeding from these by deductive reasoning. All knowledge was to conform to the mathematical ideal. Like Bacon he discounted the past and held that most of ancient learning was of little significance.

Neither of these men was as free from mediaeval ideas and methods as he claimed to be. This is shown by their uncritical acceptance of certain concepts and methods inherited from the past. Furthermore they failed to see that the actual work of scientific discovery and the creation of scientific knowledge were going forward among their contemporaries by both inductive and deductive methods combined with a considerable use of hypothesis. In other words scientific method was much more flexible and less hide-bound than either imagined it to be. Nevertheless they gave a very definite lead and direction to the philosophy of science and their followers have generally prided themselves on their emancipation from the past,—a past often underestimated and little understood—and the possession of progressive, forward-looking ideals. We have here one of the influences making for the antipathy between science and the humanities of which I have already spoken. The humanities looked much to the past, probably overmuch. The tendency to regard learning and the heritage of past thought as scarcely worth consideration is a mark left by Bacon and Descartes on the think-

ing of many of their scientific successors. They were responsible, if not for an iron curtain, at least for a heavy veil being hung between the new age and its antecedents.

Another factor in the breach between the sciences and the humanities was the dualism set up in the thought of Descartes between mind and matter, the res cogitans or thinking substance and the res extensa or spatially extended substance. The splitting of the world into mind and matter, two entirely disparate entities, led to serious metaphysical difficulties. How mind, shut up in a material body,—the ghost in the machine as Professor Ryle has called it—could be aware of the external world or in turn act upon it, was an insoluble problem. Yet this division came to be accepted readily as a common-sense truth. To the scientist the external world of matter and motion was the real world, independent and self-sustaining, and the mind or soul was merely a spectator in some mysterious way of the workings of the great world machine, of which man's body was part. The inner life of the mind was largely ignored by the scientist who came to regard it as more or less illusory, or at least something for the philosophers, poets, and theologians to worry about if they were so inclined. It was not amenable to scientific examination. Thus science and philosophy began to drift apart and the scientist became more and more indifferent to the world of values which was the primary concern of the humanist scholar.

At the same time the humanist, seeing man as a unique being with powers of mind that distinguished him so completely from the rest of the animal creation, felt that the study of external nature had little or nothing to offer to satisfy the needs of man's spiritual development. The study of the sciences was not cultural in the same sense as was the study of language and literature, of art, history and philosophy, which dealt with man himself and his activities as a self-conscious being. To the humanist the proper study of mankind was man, and not man as an animal, a part of nature, but as spirit manifesting feeling, volition, and intellect. While it was true that man played out the drama of his life on the stage of the physical world, the latter was but an incidental setting. It provided the material conditions of existence, but man himself was essentially a metaphysical being and his aspirations and ideals set him on a higher plane. Although he speaks of man as the quintessence of dust, one of the greatest humanists of all the ages wrote in the 16th century: "What a piece of work is a man! How noble in reason! How infinite in faculty! in form, in moving, how express and admirable! in action how like an angel! in apprehension how like a god! the beauty of the world! the paragon of animals!"[3]

The humanistic ideal of education was to produce men at the highest level, men of disciplined intellect but with due appreciation of moral and aesthetic values, and the sciences with their utilitarian outlook, while undoubtedly calling for intellectual discipline and training in skills, lacked the appeal to the finer sensibilities and set no store by the spiritual values which the humanist regarded as beyond price. Consequently there was high resistance to the introduction of the natural sciences into any scheme for higher education. The humanities must have priority in the education of gentlemen and of all who were to be in positions of authority or engaged in the learned professions.

Although higher education followed

humanistic lines long after the scientific revolution, scientific research was largely in the hands of men with humanistic background both within and without the universities, and was carried on mainly by private munificence and almost without public or institutional support.

The paradoxical situation in which science found itself may be illustrated by the fact that the Royal Society founded in the 17th century committed itself to an endorsement of the utilitarian ideal despised by official humanism. The patronage of Royalty and of governments was based on the prospective results of the application of science to industrial and allied arts. But even with this motive the financial support of scientific work was of the meanest. The Royal Observatory at Greenwich was founded mainly for the purpose of astronomical study which would aid the art of navigation and so provide British seamen with sound methods of finding latitude and longitude and give other information to guide them across the trackless deeps. The first Astronomer Royal to be appointed, the Rev. John Flamsteed, a poor but able curate of the established Church supporting a large family on a miserable stipend, was reduced to providing equipment out of his own pocket because of the beggarly appropriation provided for the maintenance of the Observatory. He was a first-rate astronomer and literally wore himself out compiling a star catalogue of unprecedented accuracy which became a monument to his selfless devotion to his science. I am happy to say that at his death his executors promptly stripped the observatory of the £1000 worth or so of instruments which he had personally provided out of his wretched salary, and left a thankless government with little more than the bare walls in which to accommodate Flamsteed's successor, Edmund Halley.

The claims of the sciences to be included in educational curricula were only slowly recognized, but none the less the influence of scientific thought and the body of knowledge being built up were changing men's minds and broadening the world outlook of the educated. Slowly the sciences found their way into universities and other institutions of higher learning, but it was not until well into the 19th century that they were given respectable status as branches of learning on equality of footing with the humanities. But the breach had been created and while the humanists believed that the sciences were not really cultural but merely technical and utilitarian, the scientists with their growing understanding of nature and increasing mastery of their environment were often contemptuous of the learning of the humanists and regarded it as delusive and contributing nothing to the real progress of civilization, which to them was measured by scientific advance and the increased application of science to industrial and social life.

Apart from the somewhat snobbish attitude of the humanists towards the sciences, there was a serious practical obstacle in the way of putting science into the educational curriculum: the expense. For the teaching of science, laboratories must be provided and equipped with apparatus and this implies extension of old buildings, or erection of new buildings of appropriate design and furnishing. The humanities are a cheaper educational instrument from the standpoint of boards of governors and trustees, unless, of course, the sciences can show concrete returns for the vastly increased capital expenditure. This they can do

through the applications of science to industrial arts.

It was indeed this application of science to invention and industry that gave to the sciences their dominant place in modern education. It was not the claims of science as an educational organon or a department of culture that won it the homage of institutions of learning so much as the specialized training it gave to its devotees to fit them to become experts in the rapidly multiplying industrial fields. This did nothing to lessen the thinly-veiled hostility between the humanists and scientists. It rather strengthened the opinion of the humanists that the sciences were merely technical and utilitarian studies primarily concerned with material values and only educational to a very limited degree. There was also an added feeling of resentment that money was being provided lavishly for the advancement of science teaching while the humanities languished for lack of sustenance. It became evident that, with the rapid progress of the sciences during the 19th century and the accompanying expansion of the applied sciences with the access of wealth and power that these imply, the material values of life were being greatly exalted. The humanities and the cultural standards traditionally associated with them were gradually pushed aside in the popular view and their values discounted heavily in comparison with those of the sciences. In fact there were those who, clamouring for the recognition of the sciences as the major factor in the progress of civilization, were ready to denounce the humanities as largely decorative knowledge; they could be only doubtfully regarded as contributing anything at all to genuine positive knowledge. The exaggerated importance attached to applied science was undoubtedly leading men to measure civilized life in terms of machines and goods and to segregate philosophy and religion, art and letters into a world apart, a world of the spirit having virtually no connection with the more real world of matter and energy with which science was so busily engaged. Here was the flowering of the Cartesian dualism in the concrete life of man, a dualism that the scientists had so uncritically accepted and which had now divided man against himself with a vengeance.

The fact that science itself belongs primarily to the world of the spirit and is the product of the creative activity of mind just as are literature, art, music and all the characteristically humanistic achievements, was largely overlooked. Instead of science being regarded as an important aspect of human cultural activity, it was conceived as emerging virtually complete from Nature, like Minerva springing fully armed from the brain of Jove, or rather like the genie emerging from Aladdin's lamp. It was a wonderful technique of discovery and invention but something really alien or possibly even hostile to the truly human spirit. The disposition to regard science as an alien power, and a threat to genuine culture was a common reaction of many religiously-minded people as well as of those who clung to the humanistic tradition in education. While the beneficient results of scientific research in many fields have modified this attitude in some degree, twentieth century developments, especially in sub-atomic physics and their application to the field of armaments, have reinforced the apprehension and distrust of the powers of science in millions of minds. This impulse to personify science as an alien or satanic power that may bless or curse caprici-

ously is an unconscious transfer of man's own potential qualities to the products of his creative activity. It is man himself who is the monster and the menace to his fellow beings as he had so often been in the past. But now arrayed in the trappings of modern science his power for evil is more terrifying than ever before. Ethically immature and half-disciplined, he may, under the urge of insensate ambition and a false philosophy of life, turn the vast resources of science to ignoble ends to achieve power and domination over others. Such perversion may indeed lead to the destruction of that very civilization of which he loudly boasts and a reversion to a squalid barbarism for a few possible survivors. What man needs more than additional gifts of applied science is a more thorough understanding and mastery of himself, coupled with a full recognition of those human values for which the best minds of the race, both scientific and humanistic, have striven in past ages. So far general education has failed to lift man to that spiritual level where these higher values direct and sustain life, and where the obsession with material goods and the intense preoccupation with the mere mechanics of living cease to wear down the soul. We may indeed ask ourselves the old question, "What shall it profit a man if he gain the world and lose his soul?" At the present time, in the face of the appalling problems man has contrived to create for himself, we may well pause to contemplate the final disaster, the loss of both world and soul. Our civilization has failed somewhere just when it appeared bound to achieve heights never previously attained. A distinguished American teacher of philosophy says "We are aware today that the failure to bring science into creative interaction with moral and practical life is the greatest failure of our civilization and the source of its deepest ills."[4] We may not entirely agree with this but I suggest that this judgment points again to the unfortunate breach between the humanities and sciences and the need for a new synthesis of ideas in fundamental departments of human knowledge.

It would appear from our discussion so far that the breach or pseudo-conflict between science and the humanities has resulted historically from a succession of circumstances: (1) a not unnatural lead in educational theory taken by the humanities during and following the Renaissance; (2) the Baconian and Cartesian influences on the philosophy of science in the 17th century which tended to discount the past and its values and to split the world into two sharply distinguished realms, matter and spirit; (3) the resistant attitude of the traditional humanist to the sciences in regarding them as largely non-cultural, and the counter-attitude of the scientist in viewing the humanities as merely decorative studies and of little real moment; (4) the modern swift advance of the sciences with their applications to social and industrial life, the resultant enhancement of material values and a spectacular appeal to the popular imagination which sees science as holding potentially or actually the answers to all human problems.

The question that comes to the mind here is: "Is the conflict that appears to have arisen in the way suggested a real one or is it a pseudo-conflict due to a misunderstanding of the many-sidedness of human knowledge?" The answer I would give has already been foreshadowed in the passage. I cited a moment ago about our failure to bring science into creative interaction with moral and

practical life. I believe that there is no essential conflict between the sciences and humanities; that the appearance of one is due to our cultural outlook having become distorted. The cultural perspective is wrong because of our one-eyed emphasis on this or that particular point of view. We are apt to forget that a correct perspective is a matter of unification and proportion. I speak as one interested in the unification of knowledge and in fruitful cooperation between the different departments of knowledge. In recent years with such rapid advances in every field, we think too much in compartments and delight in our small isolated systems, the value and importance of which we habitually overestimate. Language and literature, art, music, philosophy, history, science (both natural and social) are all products of human thought and imagination and reveal the many facets of human life. No one of them has a monopoly of truth about man and his world. The specialist is always with us and must always command attention, but the truly cultured man is one who has a broad generality of understanding of the world in which he lives, and a corresponding tolerance of different viewpoints and respect for the knowledge of others. Both the scientific and humanistic viewpoints must be merged in our present-day culture. They are complementary. A balanced and humane philosophy of life has always been the humanistic ideal and it is the only one fit for a civilization worthy of the name. But the new humanism must include the cultural contribution of the sciences; science must find its rightful place in the family of humanities and cease to be treated as an alien in the world of culture. I know it is frequently asserted that modern culture is dominated by science, that this is the age of science. This may be true in the anthropological sense of the term culture, where it means the sum total of the activities of a national or racial group. But I am thinking of culture in the sense of a broad generality of outlook and of standards of intellectual, moral, and aesthetic judgment set up by the best minds of the race. Science has a rightful place in ministering to these higher values, but it can easily become the servant of a new barbarism when considered mainly as an instrument of power and greedy materialism. And in this connection I would add that while in a sense this is an age of science, or more accurately of applied science, it is, in my judgment, an age not so much distinguished by scientific thought as by an immoral and blatantly offensive commercialism which in spirit is diametrically opposed to the ideals of a civilized culture and is largely destructive of the ethical and moral teaching of educational institutions. Even if science as such is not directly concerned with spiritual values, it plays a noble part in upholding the love of truth as a cardinal virtue. This fact is an important aspect of the cultural value of science, and strengthens its claim to a place with the humanities.

I have suggested that our cultural outlook has become distorted and that the distortion must be corrected by bringing the sciences and humanities into a unity through a recognition of their mutual relationships and of a need for both in a well-balanced philosophy of life. How can this be achieved? We shall set aside the larger, long-range problem of a fresh synthesis of human knowledge in its many aspects, a task which has to be faced periodically in the course of human history, and one which because of the rapid expansion of knowledge, is being

insistently pressed upon us at the present time. The more immediate and practical problem is this bringing together of the sciences and humanities into a better-balanced educational scheme which will at least give a new generation a richer and finer cultural heritage and a loftier ideal of civilization.

Educational theorists have long sought to devise a scheme, especially of secondary education, which would serve this very purpose. The very existence in our programs of studies of such a great variety of subjects both humanistic and scientific is a proof of the recognition of certain fundamental cultural needs common to all. But in spite of good intentions the result has fallen far short of the ideal.

With the growth of democratic institutions and the great expansion of industry and commerce, there has developed a demand for higher education for all who wish to avail themselves of opportunities for it. More people are going to secondary schools and universities than at any previous period in our history, and vast sums are being spent by educational authorities to give the best of everything to aspiring and ambitious students. One would expect that with the advances in educational theory of the past 50 years the cultural level would have been greatly elevated. I must confess that as a life-long teacher I am skeptical of the claim to such elevation and I am frankly disappointed with the total result. The fault lies I think, not with the ideal, but with human frailty and the refusal to face the discipline of genuine education.

There is a general impatience with learning and culture, either scientific or humanistic. People do not crave education, so much as training in some professional skill and technique, with a view to entering a trade or profession. They are more concerned with ways to make a living than with modes of living. After all, while vocational training has its place, the main business of secondary education is to prepare students for life, not as job seekers, but as men and women who are to live as members of a great society, a society of disciplined individuals who are also members one of another. Self-discipline seems to be the last thing many of us associate with the democratic way of life. Secondary education has been marked in the last twenty-five or thirty years by a futile attempt to evade the difficult disciplines by substituting something softer, something with a high-sounding name but more superficial and more easily mastered than the real thing. Many more subjects have been introduced into the curriculum at the behest of those who want education without either tears or ideas, and who think of learning as acquiring bundles of information for purposes of passing examinations and securing grades and certificates. The study of language which is the basis of all culture has fallen to a low level, with the consequence that all other serious subjects have experienced a crippling handicap. It is astonishing to find many people even in educational circles who think that proficiency in understanding and using language is relatively unimportant to a student of the sciences so long as he is acquainted with technical terms and the use of mathematical symbols and formulae. The perfunctory and wholly inadequate study of language is reflected in the common inability of high school students to read textbooks intelligently and extract the sense from a connected discourse.

Without going into a detailed discus-

sion of the shortcomings of secondary education, and I assure you I am fully aware of the uphill battle secondary school teachers are waging against the pressure of ill-informed public opinion as to what constitutes good secondary education, I would like to say a word on the question of science teaching in relation to this matter of the entente between science and the humanities. First of all I would suggest that it is the cultural aspect of science that needs to be kept in mind in high school teaching. Science is not simply a collection of interesting facts about the world of nature, neither is it a technique of invention and discovery. It is a system of thought developed by a long process of interaction of man's mind with his environment. It represents man's reaction to the natural operations going on in the world about him. It has a history which needs to be understood just as much as does the history of political and social institutions, which we commonly regard as the only kind of history that must be taught to the high school student. Unfortunately the history of scientific thinking has been largely ignored by the general historian and to a great extent also by the scientist himself, who is pushing forward the boundaries of new knowledge. The consequence is that we teach science in a cut-and-dried fashion without regard to its origins or background and as if it had no relation to any other phase of man's intellectual activity. Science has been torn out of its context; it has been isolated and treated as something of a mystery, something that has sprung up magically to exercise an inexplicable influence on human life in its modern phases. One way of re-establishing normal relations between science and other fields of learning is to approach it historically to observe how its problems arose and how they were dealt with initially by pioneer thinkers. We need to see science as a human product stamped with the tokens of man's triumphs and defeats, and shot through with the drama of his frustrations, his hopes, and his fears. Dr. J. B. Conant, former President of Harvard, in his Terry Lecture on "Understanding Science", outlines such an historical approach by a study of case histories of various scientific problems. This seems to me to be the ideal way of introducing the study of science and assures a real understanding of the nature and method of science and the logic of its structure. I am convinced that such an approach, while not demanding the cramming of many unrelated facts in a hectic race to complete an overloaded syllabus, would ensure a better understanding of science and its relation to life than is evident at present among most people who have completed a high school course. While many people affect the jargon of applied science and are more or less familiar with the multitude of devices and inventions that afflict us, few understand even the common phenomena of the natural world and what is worse, most are contemptuously incurious. In spite of the amazing advances in theoretical science achieved in this century, I sometimes feel that our industrial civilization almost merits the sardonic description of the Romans by J. L. Heiberg in his "Science and Mathematics in Graeco-Roman Antiquity": "The Romans with their narrow rustic horizon, their short-sighted practical sobriety, had always in their heart of hearts that mixture of suspicion and contempt for pure science which is still the mark of the half-educated—and sometimes bragged of it."[5] Scientific knowledge is

an important element in a sound culture but not in the way most people are accustomed to think of it. Language and literature, history, science and mathematics are the basic intellectual ingredients of any advanced culture. I am not forgetting art and music, religion and morals. While art and music are indispensable factors in culture, they occupy a special place, and while religion and morals should be taken care of by home and church ministry, the school can do a large share in promoting moral idealism, at least, in the study of literature and history.

What I have said about the historical approach to science is an expression of a growing recognition among scientists of the need to emphasize the human side of scientific study in the interests of a liberal culture in which science must play its part with the older humanities. Many scientists are deeply concerned that science has become separated from the cultural ideal of learning for its own sake, that is, for a deeper understanding of man and his world. The impersonal and detached attitude of science has been the cause of complaint by humanists, but it is partly the result of scientific method which seeks to eliminate personal feeling and bias in arriving at conclusions. However, this detachment is not a special feature of the natural sciences. In any field where impartial judgment is required even when human conduct itself is being assessed, the same restrictions are necessary. To this extent every department of knowledge has to be scientific and this is why so many studies are now more or less permeated by what we are wont to call scientific method. The whole body of knowledge that we now refer to as the social sciences illustrates the gradual entry of scientific thinking into areas which were once regarded as the special province of speculative philosophy where a priori principles reigned supreme.

The time has come for educated people to realize that the concepts developed in different fields of knowledge are not necessarily mutually exclusive, but may be reconciled in wider syntheses. As Lord Rayleigh the great mathematical physicist once remarked: "Merely to realize there are more things in heaven and earth than are dreamed of in one's philosophy is hardly an end in itself. The end should be to expand one's philosophy so as to include them." This does not mean that one's philosophy should include every phantasy that untutored minds may concoct, but it does imply patience and a resolve to think clearly in an effort to relate the different aspects of man's intellectual activity. The problem of establishing relationships will not be solved by shutting our minds to ideas and facts that are not agreeable to our accustomed mode of regarding the world. We would do well to overcome our obsession with machines and accessories, material goods and assets, and concentrate as educated people on a fuller understanding of our world. To this end we should make use of all that science and art, history, philosophy and religion have to offer.

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MENTAL MECHANISMS AND PSYCHO-PHYSICAL PARALLELS

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Part I

Introductory

This lecture is meant to be a sequel to a previous series entitled, "What is Psychological Medicine?", which dealt with the 'basic sciences of the mind' and was published in 1951 in the *University of Toronto Medical Journal* (no. 4 to 5, pp. 138 to 196). The substance of this communication is necessarily, as on the previous occasion, rather elusive a system of ideas in the field of psychological abstraction. But, even if it were termed by a materialist, 'hypothetical', this would be nothing new in the field of Medicine, nor would its usefulness be denied. A large part of medical practice is still empirical, speculatory, or conjectural. For instance, neither Heparin nor 'H-substance' have ever been demonstrated significantly in the body, yet a sizable theory and practice are based on those assumptions.

At the present state of our knowledge of what may be called the physical 'substratum' of the mind, no apologies are really needed to continue to describe psychological phenomena in psychological terms. Professor Adrian, in his talk to our Academy on the 15th of September, 1953, showed us that there was a remarkable discrepancy in olfaction between even the number of end organs, the facts of transmission of the impulse, and the eventual psychic impression and quality of odor perceived and distinguished. His very incisive researches only led him to try to breach the material gap with a further postulation of a yet unproven hypothesis: that differential concentrations of the stimuli or different kinds of "chemical transmittors" account for differences of perception in olfaction. In general, neither peripheral analysers nor Penfield's central analysers explain the mental phenomena of perception. Thus there remains the most mysterious and fundamental gap in man's knowledge of himself: namely, the translation of a series of physical phenomena: stimulus → impulse, to a series of mental phenomena: discriminatory perception → association with affect (emotion) and eventually thought and action.

When such is our state of ignorance, it seems unwise to apply even the most recent of materialistic theory—namely, cybernetics—to the mind. This theory suggests that physical phenomena can become psychological if there is a sufficient *number* of pathways and circuits (presumably in the brain) making for sufficient complexities so that the combinations and permutations (associations) of an impulse create sufficient reverberating circuits to allow for myriad of possibilities. Then it supposes that one set of associations to the impulse is selected (by conditioning and facilitation = learning), and thus a supra- or epi-phenome-

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nom of perception—the basic receptor-organ of the mind—is created. Then one would have to say that once a psychological phenomenon was so created, it would further have to create a life of its own, so to speak, with yet more complexities. This would beg the question. Moreover, one would still have to explain how perceptions of the inner and outer worlds *become conscious* (instead of automatic and unconscious) and how a mind can reflect itself to itself in *introspection*. Above all, one would have to explain how, out of such *beaten* circuits, continuously *new* creations of thoughts and feelings and insights arise. All this remembering that even the numerical (mathematical) relationship for olfaction, fails to square. Though we stand in wonderment and witness the creation of a musical composition by applied mathematics (acoustic engineering) or split-second translation of English into Russian by a machine, there is such an impossible gap between the physical and psychological, from the point of view of explaining the latter in terms of the former, and such a respectable body of study of psychological phenomena in psychological terms of abstractions, that it seems wiser to apply and further this latter study. This is not denying, of course, the strict relationship that exists. Be it sufficient to point out, and shatter man's pride in his endeavour to elevate himself to the spiritual, that the richness and complexity of man's mind is reduced, through loss of cells, in old age to a similar state in which it was when they (the cells) were not yet mature and functioning; and that mental deficit and deprivation by disease (neoplastic, degenerative or gerontogenic) is *grossly* proportional to the physical deficit.

Notwithstanding this admitted inter-dependence making man a functioning totality of brain and brawn, it is wiser for the purpose of study to think and speak of the two levels or aspects of the mental and physical whole and of the parallels between them. Nor ought we to hold to the old tenet that the scientific truth is always the simplest explanation. Haematological research for instance shows that nothing in it is simple, that the deeper one goes, the more complex the chains of biochemical inter-relationship; and that even the body has stratifications at physio-chemical, enzymatic, cellular and clinical levels.

Conceptual Background

1. The mind is not static but develops as the whole organism does, both in biological time (pari-passu with the soma) and in psychic time (its own tempo). The concept is an old one. The law stating that ontogeny repeats phylogeny applies to the mind also. The process of maturation may be called the embryology of the mind and there are a number of mental mechanisms supporting it.

2. With growth, there is continuous adaptation. Thus the two processes (maturation and adaptation) are interdependent. There could be no mental development without continuous exposure to stimuli, some of them noxious (*doloris sopitam recreant volnera viva animam*). The process of growth itself is a challenge to the adaptive capacity of the organism. Furthermore, mundane life is largely hostile and thus taxes man's inner resources. This may be the reason why there are so many more classical tragedies than comedies. The process of adaptation may be called the physiology of the mind and there are a number of mental mechanisms supporting it.

Claude Bernard's concept of the pre-

servation of a *milieu intérieure* applies and explains the essential part of the adaptive process aimed at preserving as well as elaborating the basic structures in the mind. The modern version of this general idea, as enunciated by Seyle, is equally applicable.

In connection with the newly discovered virtues of stress and of adversity, it is interesting to note that just as physiological theory has moved to postulating a waking centre instead of a sleeping one (the latter state being more basic and 'natural' to man), so, psychological theory has moved to regarding the inhibition of pleasure (reality principle) and the function of the ego in the same order of importance.

The principle of polarity subserves effective adaptation in that it allows the mind to fluctuate on a wide range between positive and negative. The polarity of emotions and attitudes is reflected in language and syntax with their converse and opposites, and in a similar way the womb and the heart, for instance, make use of polarity in regulating their delicate functions.

3. The dynamic force making for growth, adaptation and thus for life may be called LIBIDO. The *aurea lex chemiae* of "nothing being destroyed and nothing being created but everything transformed", and the Fechner law applies analogously in the principle of mental energy and its economy.

In carrying out tasks of maturation and adaptation, there is a division of labour, and it falls to the ego to fulfil the essentially human and most onerous of mental duties. The EGO is differentiated from the total personality as that part which deals with outer realities of nature and mankind and expresses itself at the level of the conscious. In contrast, the ID is that part of man which contains the animal-self and the vast store of libidinal energy, whereas the SUPER-EGO is that part which represents man as he thinks he ought to be and thus presses inner and outer moral values on the 'animal' corpus of the personality. Both the latter express themselves at the level of the unconscious.

The functions of the ego are:

1. To preserve structure, by maintaining enough stability to protect the personality from excessive external or internal conflict (comparable perhaps to the autonomic and endocrine systems).
2. To integrate and execute mental processes, so supporting the mind's development and reflecting its decay (comparable perhaps to the central nervous system).
3. The ego has the purse strings and exercises economy of mental energy (comparable perhaps to metabolism).
4. To observe the personality, since it has the *unique* capacity of projecting itself outside the personality and directing its beam of introspection deep in the dark, cobwebby corners of the psyche. Thus, the ego organizes psychological defences and achieves, mostly with success, the above-mentioned tasks by dint of a number of mental mechanisms equivalent to the physiological processes of the mind. The smooth *functioning* of the ego and its mental mechanism is insured by their being *unconscious* in the same way in which the smooth *functioning* of the body is insured by their *not* bothering us *above thalamic levels*. It is only *some* of the expressions of the ego that become conscious.

> The most remarkable thing about these mental mechanisms is the poverty of their *numbers*, when one considers their heavy duties in protecting the human mind and, also, when one compares them with the myriad of physiological processes of the body.

Yet in one sense, there are physical parallels for this poverty of numbers of reactions: Despite a multitude of injurious agents attacking the body (from living bacteria to physical agents), the body reacts in only one kind of way: inflammation. There are other examples of different stresses producing the same kind of response; for instance, the 30 or more 'causes' of splenomegally, the different ways of producing an atheromatous reaction, or a rise in blood pressure. Perhaps the best example of this poverty of reaction-types is seen clearly in the newest of organs or systems. The brain, and particularly the cortex, teaches us how many different kinds of stresses produce indistinguishable reactions in cerebral tissue and in clinical manifestations. Thus, encephalopathy is an example where deprivation of oxygen or glucose, toxins, infections, lack of vitamins, and many different 'causes' give the same kind of reaction and the same order of impairment of cerebral function.

The ego scans conscious and meaningful perceptions with its feeling—tone or mood, in the same way in which the cortex is scanned by the α rhythm. Upsets in mood, and the play of emotions come in where circumstances induce conflicts in the same way in which the α rhythm is broken by stresses, obstacles or an interplay of stimuli.

If the patho-physiological responses to stress are limited in number, their highly subjective components, the emotions, (like their physical symptoms—cousins) are even more limited. They stratify and range bi-polarily from the basic couple, pain and pleasure, through interest—apathy, excitement—dejection, elation—depression, anxiety—indifference, fearfulness—calmness, and a few such, to the more complex hatred—love and, finally, happiness. Here, too, the body provides analogues in that the entire range of psychic pain, either acute and localizable, as in being grief-stricken, or diffuse, as in panic, is similar to physical pain, either acute or localizable, as that associated with a nerve dyscrasia, or diffuse, as that associated with a viscus. Also, in general, symptoms (constitutional and subjective) are but a few though their causes are many: To instance again, fatigue may be due to diabetes, tuberculosis, neoplasm or boredom.

Let us consider for a moment dysfunction: The importance of these mental mechanisms cannot be over-emphasized for when they become deranged, their description forms the basis of nomenclature of what has now become a psychiatric 'disease'. This is, of course, a most unsatisfactory state of affairs since most mental mechanisms (like the equivalent somatic processes) come into function daily to a greater or lesser extent and vary in pattern. To select the leading mechanism gone wrong and to ascribe to it a disease is a real disadvantage. For instance, projection, when excessive, is the basis of a paranoid state: that is, when the individual constantly blames another, or sometimes objects, for all his mishaps. The same exaggerated projection is 'normal' in childhood, in fairy tales and in dreams. Like with the heart muscle whose histology fails to mimic disturbance in total function, so the excessive use of a mental mechanism only

reflects disturbances when the individual is taken as a whole. Then, there are almost as many different classifications of deranged mechanisms and, therefore, mental diseases, as there are authorities diagnosing. Yet when one remembers that the same criticism applies to the study of meningioma and also to the histology of hepatitis and cirrhosis—both of which are *visible*—one need not be downcast at the variability of human *interpretation*. Nonetheless, 'a more reliably uniform system of classification is needed for adequate prognostication and a better approach to therapy. The present system is obviously too crude and gross, and resembles the stage in Somatic Medicine when many different diseases were assembled under the diagnostic category of a symptom such as cough or fever. As a result of the poverty of reaction-types to various stimuli, another analogy with the body holds: Confusion and 'spread' of a reaction may occur in the face of a variety of stimuli following a strong stress. In the mind, anxiety may be provoked originally by a specific thing, but eventually by such divers situations as eating meat, being in crowds or in an enclosed space, or the feeling that the throat is gagging. Here, as in endocrinology (see Seyle), the anamnestic reaction of bacteriology applies analogously. To remind you of it: the antibody titre is enhanced following injury by a variety of non-specific substances other than the original antigen! This phenomenon is also reminiscent of the facilitation and reinforcement of conditioned reflexes.

In the realm where physiology borders pathology, the bi-polar reaction also can become deranged in the psyche. The normal mixture of love and hatred, originally a useful range, may concentrate on the same person or object and co-exist to the same intensity so as to form the morbid state of ambivalence and actually cause death. This bi-polar reaction is not often seen in the body to co-exist in time (as in dysmenorrhoea or delayed birth or tenesmus) but it is seen in the course of time. For instance, polycythaemia, originally a useful response to anoxia, may become aberrant in the idiopathic state (Osler-Vaquez disease) and end in aplastic anaemia.

There may be failure too in the *economic* department: (1) Either an excessive *stimulus* or deprivation (say the loss of a loved one) may cause grief and a 'nervous collapse' with tears, and exhaustion, all of which may be helpful in conserving energy and remustering strength. But the collapse may also end in the 'catastrophic reaction', in the same sense in which the collapse of shock with hypothermia and hypotension are protective devices which may become lethal. In a milder range of reaction, fatigue, calling for rest, may itself become abnormal. This may be the equivalent of Seyle's stage of resistance, following shock and counter-shock. Interestingly enough with regard to fatigue, whereas in theory it is a teleologically understandable reaction its mechanism remains actually unrevealed. Neither the cause of mental fatigue nor of sleepiness is clear, any more than it is known how a theoretically indefatiguable muscle tires. (2) The parallel examples of an excessive *reaction* must also be given. Just as pyrexia fails to favour the anti-infection defenses of the host or the annihilation of the parasite or invader, so hostility (red-hot anger) helps neither the mobility of the host in defense (it may freeze the host!) nor the annihilation of the enemy. A further extension

of these ideas brings us to Wolff's theory of psychosomatic dysfunction and ultimately disease. He states that when a combination of psychic and somatic reactions, originally adequate for defense, prolong their actions unnecessarily, even after the original stress is withdrawn or altered they become part of the 'cause' of the disorder.

These considerations show up the occasional unwisdom of the body and the mind. The mind, perhaps more than the body, being newer in creation, is limited and imperfect.

Summary: It was explained why it is essential to continue to study and describe psychological phenomena in psychological (rather than physical) terms. Thus the basic postulates for mental functioning were laid down. It is intended, in the next two parts, to describe mental mechanisms, as part of basic mental functioning. Throughout, it is intended that the reader look at and accept the psychological concept (at times illusorily 'elevated') from familiar physical ledges (parallels).

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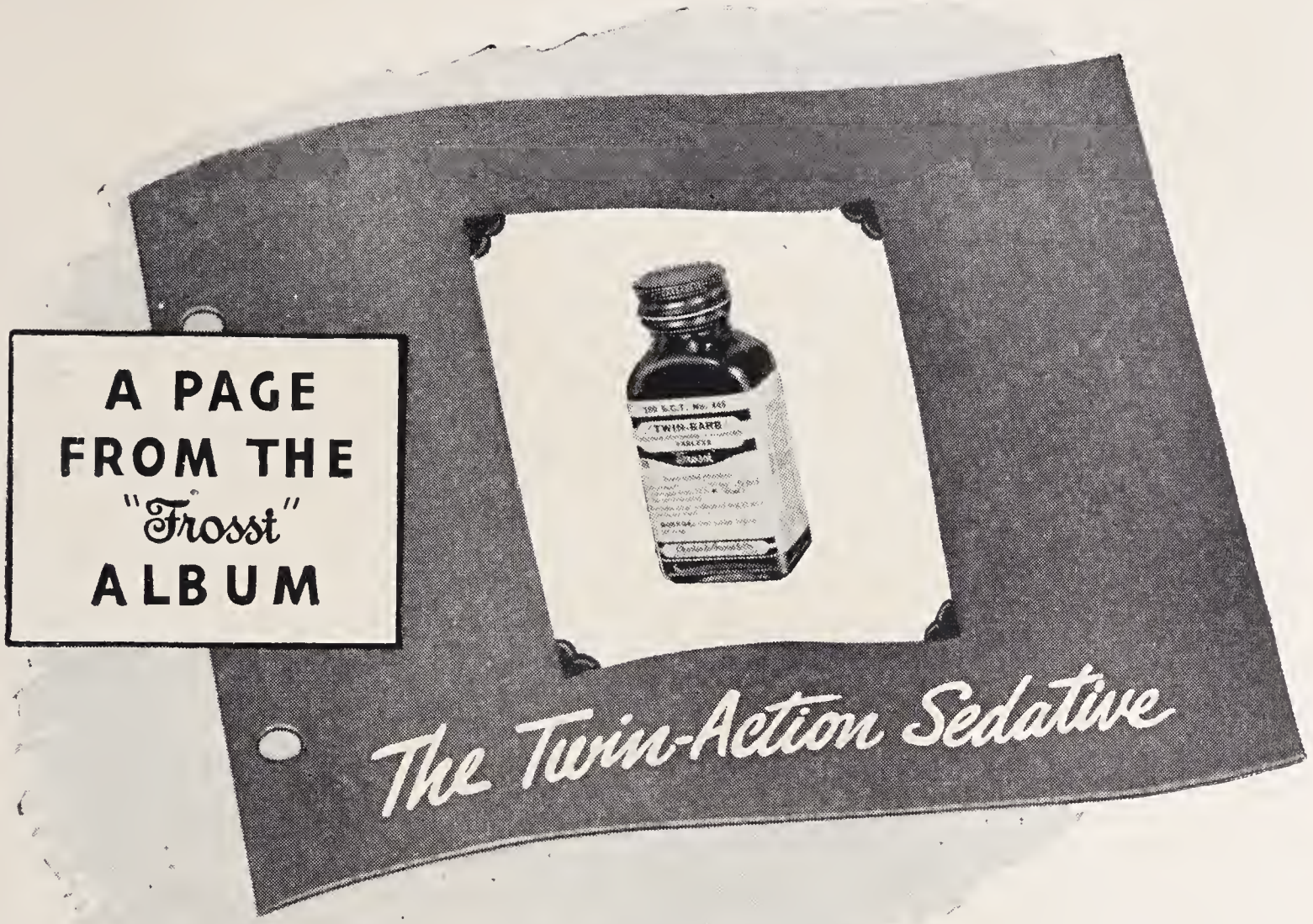

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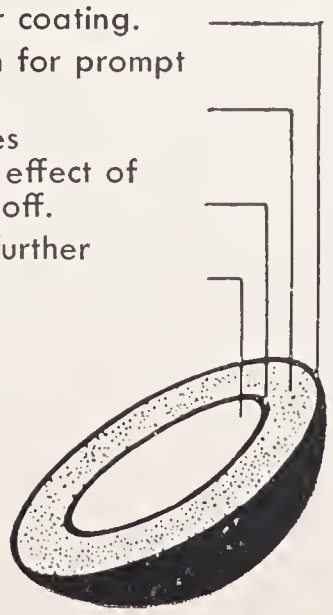
SINCE 1899
THE SYMBOL OF PROGRESS IN PHARMACEUTICAL RESEARCH

Charles E. Frosst & Co.
MONTREAL CANADA

TABLET CONSTRUCTION

Rapidly soluble outer coating.
Pentobarbital sodium for prompt sedation.
Inner coating dissolves approximately when effect of pentobarbital wears off.
"Noctinal" provides further sedation.



for simple, effective
control
without a diaphragm

with measured-dose
applicator

Ortho

* TRADE-MARK REGISTERED

an ancient and honorable profession
Pharmacy

The Apothecary — a woodcut by Jost Amman, 1568.
(The Bettmann Archive)

Experience Proves it Pays to

LET THE PHARMACIST DO *ALL* YOUR DISPENSING

Time and again, the record shows that the practice of medicine offers greater rewards and satisfactions when divorced from needless details and expenses. This is obvious, when the stocking and dispensing of today's myriad pharmaceuticals is left entirely to the doctor's highly-skilled co-worker — the friendly pharmacist.

THE ONTARIO RETAIL PHARMACISTS ASSOCIATION

ONTARIO RETAIL PHARMACISTS ASSOCIATION

A PAGE FROM THE "Frosst" ALBUM

"BEFORTE"

TABLETS

VITAMINS B WITH C AND D

An Outstanding B-Complex Formula

. . . at average cost!

"BEFORTE"

Tablet No. 360 "Frosst"

Brewer's yeast concentrate ..	150 mg.
Vitamin B_1	5 mg.
Riboflavin	3 mg.
Niacinamide	12.5 mg.
Pyridoxine hydrochloride	1 mg.
Vitamin B_{12}	**1 mcg.**
Vitamin C	35 mg.
Vitamin D	500 Int. Units

FOR THE PREVENTION OF NUTRITIVE FAILURE AND THE TREATMENT OF VITAMIN DEFICIENCY STATES

DOSE: Prophylactic — one to two tablets daily; therapeutic — one to two tablets, 3 times daily.

MODES OF ISSUE — Bottles of 30 and 100.

Frosst — SINCE 1899 — THE SYMBOL OF PROGRESS IN PHARMACEUTICAL RESEARCH

Charles E. Frosst & Co.

MONTREAL CANADA

to combat

FATIGUE

and

nervousness

"BEMINAL" with phenobarbital

No. 819

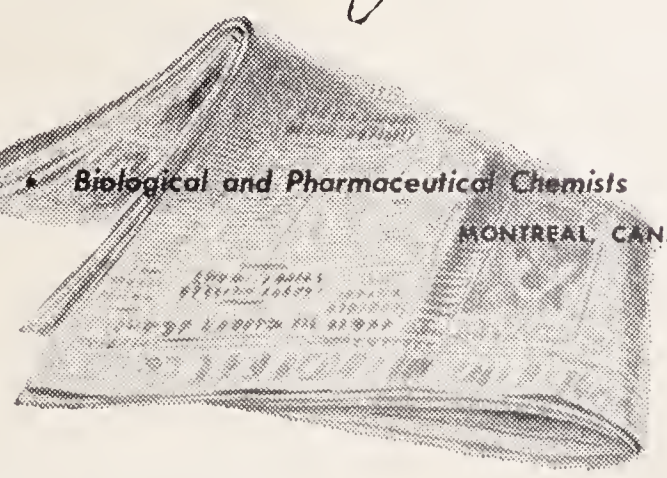
A direct approach to the relief of anxiety and the restoration of appetite—with a consequent improvement in physical condition and mental attitude.

Suggested dosage: one tablet 3 times daily.

Each tablet contains:

Thiamine	5 mg.
Riboflavin	2 mg.
Niacinamide	10 mg.
Vitamin B_{12}	1 mcgm.
Pyridoxine	0.5 mg.
d-Panthenol	2 mg.
Ascorbic Acid	25 mg.
Phenobarbital (¼ gr.)	16 mg.

In bottles of 100 and 1000



Ayerst

Ayerst, McKenna & Harrison Limited • *Biological and Pharmaceutical Chemists*

MONTREAL, CANADA

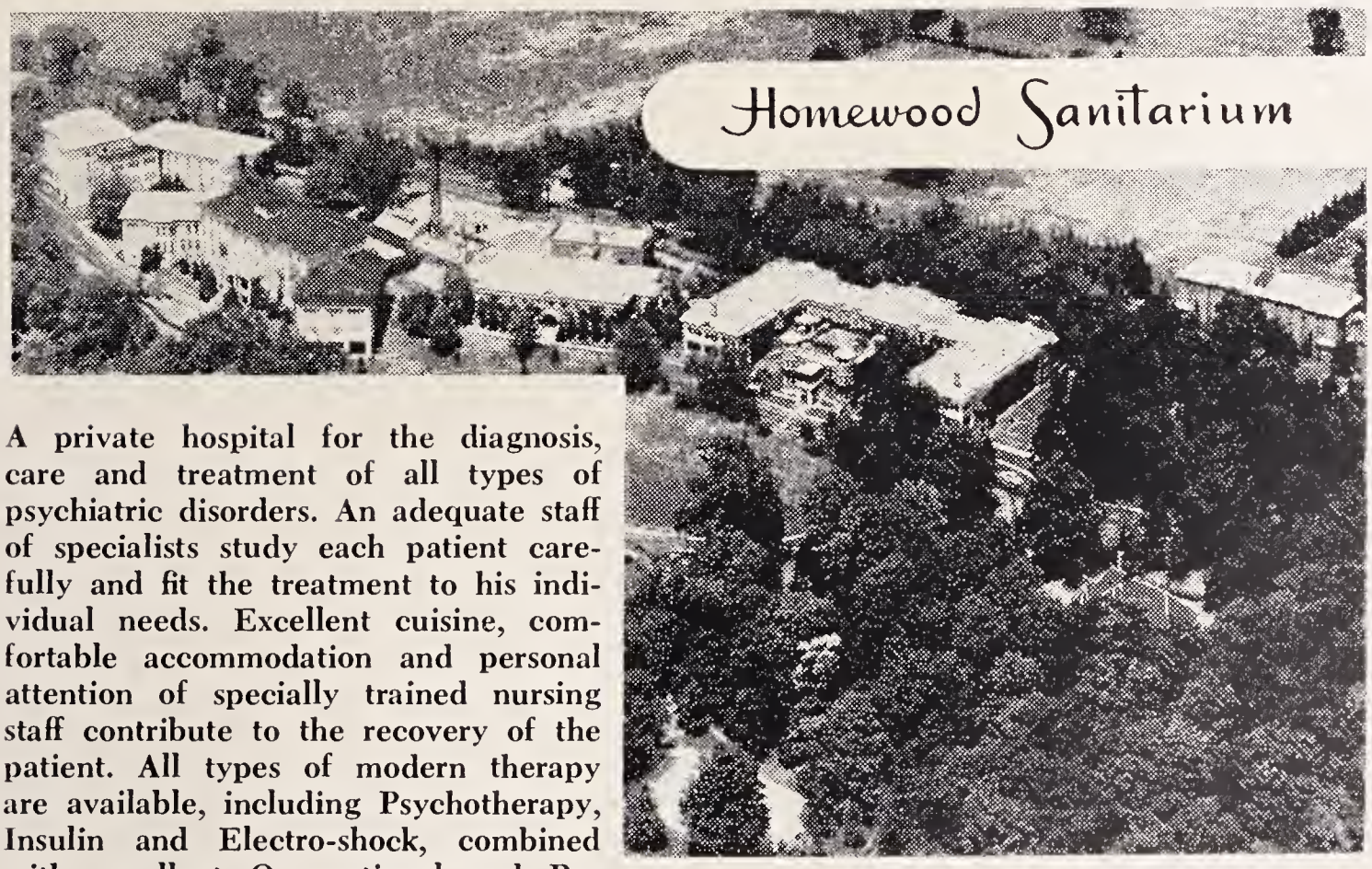
1454

multiple
sulfonamide
to control vaginitis

For the Failing Heart of Middle Life
Prescribe 2 or 3 tablets of Theocalcin, t. i. d. After relief is obtained, continue with smaller doses to keep the patient comfortable. Theocalcin strengthens heart action, diminishes dyspnea and reduces edema.

Theocalcin, theobromine-calcium salicylate, T. M. Reg. Canada Product of Bilhuber Knoll Corp., Orange, N. J.

MERCK & CO. Ltd. Selling Agents **MONTREAL**

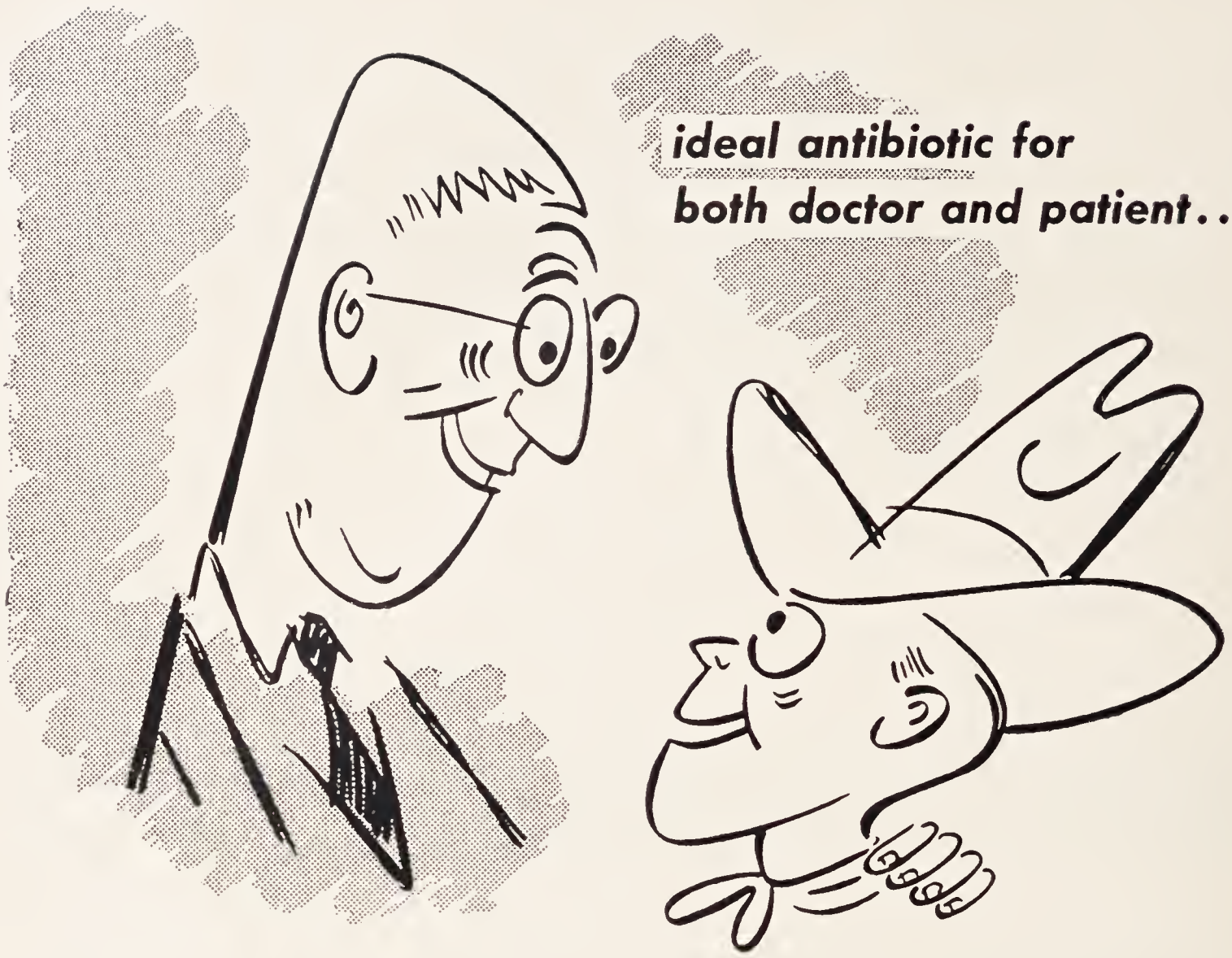


A private hospital for the diagnosis, care and treatment of all types of psychiatric disorders. An adequate staff of specialists study each patient carefully and fit the treatment to his individual needs. Excellent cuisine, comfortable accommodation and personal attention of specially trained nursing staff contribute to the recovery of the patient. All types of modern therapy are available, including Psychotherapy, Insulin and Electro-shock, combined with excellent Occupational and Recreational facilities.

The Sanitarium buildings, accommodating 225 patients, are situated in a very attractive setting within the confines of the City of Guelph. Visits by physicians and other interested parties are always welcomed. For further information write or telephone (Guelph 53).

A. L. MacKINNON, M.B.,
Medical Supt.

THE HOMEWOOD SANITARIUM OF GUELPH, ONTARIO, LIMITED



ideal antibiotic for both doctor and patient...*

Oral Suspension BICILLIN is dispensed ready to use, requires no tedious preparation. Because it is stable for 2 years without refrigeration, there is no risk of loss of penicillin potency during a course of therapy. It is not affected by gastric juice. *Of particular importance in treating children, Oral Suspension BICILLIN has the advantage of *extreme palatability*.

The most important—and an entirely unique—advantage of Tablets BICILLIN is, of course, that only 3 tablets daily will provide uninterrupted, therapeutically effective blood levels of penicillin. Tablets BICILLIN have all the BICILLIN advantages of efficacy, long action, tastelessness, and extreme resistance of loss of potency by action of gastric juice and penicillinase.

BICILLIN 100 SUSPENSION
Bottles of 2 fl. ozs.
100,000 I.U. per 5 cc. teaspoonful

BICILLIN 300 SUSPENSION
Bottles of 2 fl. ozs.
300,000 I.U. per 5 cc. teaspoonful

BICILLIN 200 L-A TABLETS
Bottles of 100 Vials of 12
200,000 I.U. per tablet.

BICILLIN

DIBENZYLETHYLENEDIAMINE DIPENICILLIN-G

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